VOLUME II NUMBER 5

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY
OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

EDITOR

C. A. CHANT
University of Toronto, Toronto

ASSOCIATE EDITORS

W. F. KING
Chief Astronomer
Ottawa

R. F. STUPART
Director of the Meteorological
Service of Canada, Toronto

J. S. PLASKETT
Dominion Observatory
Ottawa

PUBLISHED BI-MONTHLY

SEPTEMBER-OCTOBER, 1908

PRINTED FOR THE SOCIETY
TORONTO: 198 COLLEGE ST.
FOREIGN AGENTS: WILLIAM WESLEY & SON,
28 ESSEX ST., STRAND, LONDON.

THE JOURNAL

OF THE

ROYAL ASTRONOMICAL SOCIETY

OF CANADA

VOL. II. SEPTEMBER-OCTOBER, 1908. No. 5

The Sun's Motion in Space	*W. H. S. Monck*	223
Myths and Fancies of the Milky Way	*W. J. Wintemberg*	235
Notes on Double Stars	*T. E. Espin*	248
Lake Undulations	*F. Napier Denison*	251
Note to Mr. Denison's Paper	*W. J. Loudon*	254
Meetings of the Astronomical Society of America	*J. S. Plaskett*	255
Meetings of the Society at Toronto	*E. A. D.*	261
" " " " " Ottawa	*J. S. P.*	265
" " " " " Peterborough	*E. F.*	267
Notes from the Dominion Observatory		269
Astronomical Notes		274
Summary Report of Weather in Canada for August and September		276

Editorial communications should be addressed to C. A. Chant, University of Toronto, Toronto, Ont.

Business correspondence, remittances, etc., should be addressed to J. E. Maybee, Treasurer of the Society, 103 Bay St., Toronto.

$2.00 per annum. Single numbers, 35 cents.

Subscription to the *Journal* and the Society's Annual *Handbook* is included in membership fee.

University of Toronto

INSTRUCTION given in the University Faculties of Arts (degrees of B.A., M.A. and Ph.D.), Medicine (M.B. and M.D.), Applied Science (B.A.Sc., C.E., M.E., E.E.), and in the Colleges and Schools of Dentistry, Pharmacy, Agriculture, Music, Household Science and Veterinary Science.

Fully equipped Library and Science Laboratories, Gymnasium and Recreation grounds for Physical Culture.

Thorough course of preparation in all branches for professional or business career.

For calendar and all information apply to JAMES BREBNER, B.A., Registrar.

University College

UNIVERSITY COLLEGE is, since the Federation Act of 1887, the complement, in the system of higher education provided by the State, of the University of Toronto.

The State furnishes through University College, instruction in those departments of the Arts Course in which it does not furnish instruction through the University.

These departments are Greek, Latin, Ancient History, English, French, German, Oriental Languages and Ethics.

MALCOLM W. WALLACE, Ph.D., Registrar.

THE JOURNAL
OF THE
ROYAL ASTRONOMICAL SOCIETY
OF CANADA

VOL. II. SEPTEMBER-OCTOBER, 1908. No. 5

THE SUN'S MOTION IN SPACE

BY W. H. S. MONCK

THE Sun's motion in space is not a very difficult or intricate problem, though an accurate determination of it may require an extensive collection of observations and a large amount of computation. The principles involved are simple, and a rough determination is pretty easily obtained. The first determination, which was made by Sir Wm. Herschel, was based on the proper motion of 14 stars only, and some astronomers seem to think that it was owing to some lucky chance that his result agreed so closely with recent computations based on much more extensive data. I am not of this opinion. On the contrary I think the Sun's motion in space forms such an important factor in the observed proper motions of the stars that 14 stars impartially selected from diffrent quarters of the sky would be almost certain to afford indications of it. It is in fact the most potent cause of these motions; but there are other less potent factors, which, though they do not alter the region of the sky towards which the Sun is moving, may have the effect of displacing the actual direction of this motion by several degrees. It would be a mistake to regard the Sun's motion as a residual phenomenon which could only be brought to light by comparing

a great number of observations, like the diurnal variation of the barometer, in which it requires observations extending over a great number of days to discover that the barometer is on the average higher at one hour of the day than at another.

We cannot by mere inspection distinguish between absolute and relative motion. This is the foundation of the Copernican theory, according to which, what we suppose to be motions of the Sun are really motions of the earth. But we have instances within the solar system in which absolute and relative motions both take part in producing the apparent (or observed) motion. The apparent motion of a planet is partly the result of the planet's own motion and partly the result of the earth's motion, and the early Copernican astronomers found it no easy task to assign to each of these causes its proper influence. Now if the Sun is moving in space, the apparent motion of the fixed stars must be of this kind. The Sun's motion cannot account for the whole of the observed motions, since, for instance, we often find two stars moving in contrary (or almost contrary) directions; but on the other hand the motion of the Sun towards any point will cause the fixed stars (apparently) to move away from that point. What is called the proper motion of the star—its apparent proper motion—will therefore be a composite, consisting partly of its true proper motion and partly of the motion which we ascribe to it in consequence of the Sun's proper motion—which latter motion is always directed away from the point towards which the Sun is moving.

The Sun is a star and the stars are suns: and probably there are as many stars larger than the Sun as there are smaller than it. Their distances from the Sun moreover are very great. If the Sun were influenced only by the nearest star, *α Centauri*, I am afraid to say how long it would take to complete a revolution round that star. To suppose therefore that the hundred millions of stars which are within the range of our best telescopes are all sensibly influenced by the Sun's attraction is therefore absurd. They must be moving independently of the Sun and we can hardly suppose that they have on the whole any tendency to

move either in the same direction as the Sun or in the opposite direction. And the Sun, having no near centre to revolve round, must (if not moving in a right line) be taking a wide sweep through space—a curve the direction of the tangent to which has not sensibly altered since the date when our observations on proper motion began. (The fact that all the stars which have been accurately observed are moving, goes far to prove that the Sun is moving also, but other evidence of this will be referred to hereafter). The Sun may therefore be regarded as moving towards a fixed point in the sky while the stars having no general tendency to move either in the same or in the contrary direction, their motions measured in that direction will on the whole balance each other. Referred to that point, the number of approaching and receding stars will be equal. But the Sun's motion impresses an apparently receding motion on *all* the stars. The receding stars will therefore appear to outnumber the approaching stars; and if this numerical excess is large we may conclude that we have found, not indeed the point towards which the Sun is moving, but a point in pretty nearly the same direction. For as long as the direction is nearly the same, the Sun's motion will produce an apparent receding motion in the great majority of the stars. The disproportion between the two sets of stars ought to reach its *maximum* at the right point, but for some degrees on every side it may be great enough to throw doubt on the true position of this *maximum*. But if there is a region of the sky in which, when we take any point at random, the receding stars always exceed the approaching stars, it may I think be fairly concluded that the Sun is moving towards some point included in this region.

The proper motions of the stars are usually measured in Right Ascension and Declination. I consider Right Ascension alone here for the sake of simplicity. Let the R. A. of the point towards which the Sun is moving be 18^h or 270° (probably not far from the truth, though I only use the figure for the sake of illustration). The Sun's motion in space makes all the stars apparently recede from this point; but this receding motion

tends to increase the R. A. of the stars between the 18th and 24th hours and to diminish that of the stars between the 12th and 18th hours since both sets of stars are driven away from R. A. 270°. A star whose R. A. is 270° is unaffected by the Sun's motion so far as Right Ascension is concerned. The Sun's motion therefore only influences its Declination. Thus 270° may be regarded as a neutral point, separating the region where the Sun's motion increases the R. A. from that in which it has the contrary effect—separating the region in which increasing Right Ascensions may be expected to preponderate from that in which diminishing Right Ascensions may be expected to preponderate. There is a second neutral point situated at about R. A. 90° which separates the same two regions at the opposite extremity. Starting from R. A. 0°—the first point of Aries—we have increasing Right Ascensions up to R. A. 90°, diminishing Right Ascensions from R. A. 90° to R. A. 270°, and increasing Right Ascensions again from R. A. 270° to R. A. 360°. Such is the the theory. What are the results of observation? It is impossible to take up any Star Catalogue in which the stars are arranged in order of Right Ascension (and their proper motions given) without seeing that, roughly speaking, these conditions are fulfilled. In extensive regions of the sky we meet with three times as many stars with increasing Right Ascensions as with diminishing Right Ascensions, while in other extensive regions we meet with the exact reverse. It is thus clear the Sun is not merely a factor, but a very potent factor, in these observed motions of the stars. Its influence is, I think, the dominant influence. But, as was naturally to be expected, when we get near the neutral points the disproportion between the two classes of stars becomes less, and the change being slow it is not easy to fix the exact neutral points with precision. Moreover, while theoretically they ought to be separated by 12^h or 180° some catalogues seem to give unequal spaces to the two regions. Thus in M. Bossert's Catalogue of Stars with large proper motion the region of diminishing Right Ascension seems to extend over 13^h or 195°, leaving only 11^h or 165° for the

region of increasing Right Ascensions. And in this case there is much uncertainty as to the second (or principal) neutral point, the stars with increasing R. A. not gaining a steady predominance till about R. A. 200°, before which point there has been considerable fluctuation. The broad features are quite distinct, but accurate determination is a different matter.

The stars, as a whole, have no tendency to move in the same direction as the Sun or in the contrary direction. But there are groups of stars which appear to be drifting in (roughly speaking) the same direction; and if, in endeavouring to determine the Sun's motion, we select too many stars from such a group we shall get a result in which the direction of the Sun's motion is more or less displaced. The examination of such groups seems to form a necessary preliminary to an accurate determination of the Sun's motion in space. Professor Kapteyn, Mr. Eddington and Mr. Dyson—I think there are others also—have applied themselves to this subject, and arrived at results which, even if I had studied them more closely, I do not feel competent to criticise in detail. But the agreement between their results is not very close, and therefore none of these results can be regarded as scientific truths. They all, I think, regard the stars—at least those in the Catalogues which they have examined—as made up of two great star-streams, each (roughly speaking) directed towards a particular point in the sky. I doubt whether such a generalization is not too wide, while even if correct it might be best led up to by examining smaller groups.

The importance of the Galaxy can hardly be overlooked by any astronomer, and Professor Kapteyn's two streams are directed to points on it. The Galaxy appears to be a ring, the central line of which forms a great circle on the celestial sphere. Does this ring revolve? Of course it does not revolve in the sense that a material ring held together by cohesion revolves. Even Saturn's rings are not believed to revolve in that sense. But I would rather compare the Galaxy to the region of asteroids in which, though every star revolves in the same direction round a central sun, the mean distances, periods and eccentricities

differ considerably, and the orbit-planes often make considerable angles with each other. I do not think there is any evidence of a central sun or star in the Galaxy, but nevertheless the Galactic Stars may have a common motion of revolution in the same sense that the asteroids have it.

I referred to my examination of M. Bossert's Catalogue of Stars with large proper motions. After ascertaining what I have called the two neutral points (as regards Right Ascension), I was struck by the fact that they agreed very closely with the two points in which the plane of the Galaxy intersects the Equator. Further, the Galaxy is narrow and well defined in Taurus, where one neutral point is situated, while it is diffused and partially double near the other neutral point in Ophiuchus. But in Taurus the change from preponderating movements in increasing R. A. to preponderating motions in diminishing R. A. is comparatively abrupt, while in Ophiuchus it is slow and there is more than one fluctuation. Further, the region of increasing R. A.'s is smaller than the region of diminishing R. A.'s in the proportion of about 11 to 13, and the stars with increasing R. A. in the Catalogue only number about 1190 against 1450 with diminishing Right Ascensions. All this looks as if near the neutral point in Ophiuchus there was some cause which counteracted the effect of the Sun's motion in space; and such a counteracting cause would exist if the revolution of the Galaxy caused the Galactic Stars in Ophiuchus to move in the direction of Taurus. Suppose the true neutral point to be at 270° R. A., and consider a Galactic Star at 271° R. A. The Sun's motion would cause an apparent motion towards 272° R. A., but the supposed revolution of the Galaxy would cause a motion directed towards 270°. The latter effect might be stronger than the former, with the result of placing 271° R. A. in the region of diminishing Right Ascensions, though its true position was in the region of increasing Right Ascensions. The revolution of the Galaxy (if it exists) may therefore lead to a displacement of the direction of the Sun's motion in space: and some other Catalogues that I have examined lead to results somewhat similar to

those deduced from M. Bossert's. One Catalogue, however, leads to an opposite conclusion. It is a Catalogue of Zodiacal Stars published by the Navy Department at Washington. I mentioned that one of the neutral points (as regards R. A.) is situated in Taurus, and as a preponderance of increasing Right Ascensions passes into a preponderance of diminishing Right Ascensions by degrees, I expected to find the number of stars in each class in that constellation nearly equal. Instead of that I found about 140 increasing Right Ascensions to 30 diminishing —not far from the highest proportion in the Catalogue. The transition took place in Gemini and in the earlier portion of this constellation, the diminishing Right Ascensions in Gemini being on the whole more numerous in the proportion of 60 to 40. How is this great preponderance of increasing Right Ascensions in Taurus, so near the neutral point, to be explained? The Galaxy runs through Taurus and it would seem that owing to the revolution of the Galaxy the Galactic Stars in Taurus are increasing their Right Ascensions, though the Sun's motion has ceased to have any considerable effect on their apparent motions in R. A. But if so the Galaxy must be revolving in the opposite direction from that previously suggested, and the question arises whether both sets of motions are not attributable to causes of a more local character than a revolution of the Galaxy. In this Catalogue the two critical points are pretty nearly 12 hours apart and there is some fluctuation in the case of the later one, but a remarkable feature which extends almost over the whole Catalogue is the great preponderance of stars with increasing North Polar Distances. This is much greater than the Sun's motion in space would account for, and must, I think, be ascribed to some other cause.* As the greater part of the Galaxy lies entirely outside of the zodiacal zone it cannot, of course, be ascribed to the Galaxy.

Another Catalogue which I thought might throw light on the subject was that of circumpolar stars observed by Mr. Car-

*The disproportion is very great in Taurus. It is in the direction which the Sun's motion would cause, but much greater than we should expect from that cause by about 16 to 1.

rington and re-observed at Greenwich Observatory. As the Galaxy does not approach within 10° of the North Pole, these stars would (I thought) be free from Galactic influences. In some respects the results were such as I expected. The two neutral points were nearly 12 hours apart, and the stars with increasing and diminishing R. A.'s were almost equal in number—abont 570 to 540. But the neutral points instead of being situated at about 90° and 270° R. A. were situated at about 60° and 240° R. A. Could the proper motion of the Galaxy have displaced the direction of the Sun's motion (in R. A.) to the extent of 30°, or 2 hours? But computations based on the motions of the stars in the line of sight seem to assign even a smaller R. A. to the direction of the Sun's motion. I noticed the remarkable preponderance of motions in increasing North Polar Distance among the Zodiacal stars. On the other hand I find a preponderance (though not so large) of diminishing North Polar Distances among Carrington's circumpolars; and I think, taking the latter as a whole, the Sun's motion in space ought to produce the contrary effect. The peculiarities which affect the Zodiacal stars and the circumpolar stars are probably of a local character and suggest the desirableness of preparing more local catalogues and examining them carefully. No doubt the direction of the Sun's motion ought ultimately to be arrived at by means of a Catalogue extending as impartially as possible over the whole sky: but if we find that particular kinds of motions prevail in a particular locality, we must take care not to include too many stars from that locality among our *data*. Moreover, our observations in the Northern Hemisphere are much more complete and accurate than in the Southern, and if there are any kinds of proper motions which prevail more largely in the one hemisphere than in the other, those which prevail in the Northern Hemisphere have probably received undue weight in the great majority of our computations. I may add that very small proper motions are seldom known with an accuracy that justifies their employment in such computations. The probable error is too large in comparison with the result arrived at. A general catalogue in-

cluding all the stars whose proper motion has been ascertained with a fair degree of accuracy is a *desideratum*, but the use of it would no doubt lead to very lengthy computations. The stars whose proper motions can be determined with accuracy are comparatively near us. Very remote stars must necessarily appear motionless or almost motionless in consequence of their great distances. But they constitute the great majority of the 100,000,000 stars which are capable of being observed. The present generation will not see a determination of the Sun's motion based on the observed proper motions of 100,000 stars, but even then the direction arrived at might be sensibly influenced by local causes which did not affect the remoter stars which outnumbered those used in the computation in the proportion of 1000 to 1. Different results have been obtained by the same computer when stars with greater or less proper motion were used in his computation. One explanation of this difference is that the motions of the nearer stars are influenced by local causes which do not extend, or only extend, in a minor degree, to the remoter ones. Other explanations, however, are possible ; for instance, systematic errors of observation or computation which more largely affect the result as the proper motions dealt with become smaller. (I do not think that the Sun's orbit can be sufficiently curved to admit of the explanation that the difference in the computed direction of the motion is caused by the different duration of the light-passage in the two classes of stars compared).

Besides motion in R. A. and Declination, however, a third element has to be considered—motion in the line of sight, and spectroscopic observations on this kind of motion possess one great advantage—it does not require a series of observations extending over a great number of years to ascertain the motion of a star whose spectrum is bright enough for measurement. The principles applicable are those already considered. The stars taken as a whole have no tendency either to approach the Sun or to recede from it, and therefore a preponderance of approaching stars in one part of the sky and of receding stars in the opposite part of it indicates that the Sun (carrying the earth with it) is

moving towards the former and away from the latter. Little, however, has hitherto been done in ascertaining whether there are systematic motions in the line of sight which might displace the direction of the Sun's motion as computed in this manner. The method also affords a mode of ascertaining the Sun's velocity in space. If, for instance, the stars near the point towards which the Sun is moving give on the average an approaching velocity of 10 miles per second, while those near the opposite point give an equal receding velocity, we may infer that the Sun is moving in this direction with a velocity of about 10 miles per second. Its results also assist us in estimating velocity in miles per second from observed angular velocity. Right Ascension and Declination are both at right angles to the line of sight and on a general average the motion of the stars in all three directions is likely to be equal. And the considerations already referred to enable us to compare the effect of the Sun's motion in R. A. with the real proper motion (in R. A.) of an average star. For instance, of 1000 stars taken at random, according to our original assumption the true proper motion of 500 will agree (roughly) with the Sun's motion, while that of the other 500 will disagree with it. Suppose that actual observations give 750 of one class to 250 of the other. Then the Sun's motion is potent enough to reverse the apparent motion of 250 stars out of 500, leaving the remaining 250 unreversed; so that the Sun's velocity in this direction is just equal to that of an average star. But I need hardly point out that a star moving in space with a velocity of 10 miles per second would have a smaller velocity in R. A., in Declination and in the line of sight. Each of these velocities would, I believe, be the total velocity divided by the square root of 3. If we were able by this means to ascertain the average velocity of stars having a given proper motion (*i.e.*, true, not apparent proper motion) we could also compute the average parallaxes of these stars. But such averages could not be relied on in individual cases and, moreover, any Catalogue of stars with considerable proper motion will include many stars whose real velocity is much over the average and others whose motions

are nearly perpendicular to the line of sight. It has been noticed by myself among others that stars of the solar type have much greater proper motions relative to their brightness than those of the Sirian or Orion types. This conclusion was based on their motions in R. A. and Declination only, and I inferred that the solar stars gave less light relatively to their masses (or rather, perhaps, relative to their surfaces) than those of the Sirian or Orion types. Observations of the motions in the line of sight ought to clear up this question. If the greater proper motion of the solar stars is real and not apparent, this fact ought to appear from an examination of their spectroscopic velocities. Average distance or parallax cannot be inferred from average proper motion unless the average velocities are equal.

But if we desire to deduce the direction of the Sun's motion from stars situated at different distances from us in order to see whether they lead us to the same results or not, we ought not to take the observed proper motion as indicating the relative distances of different groups of stars. For there are groups of stars in which the observed proper motion is equal to the true proper motion plus the effect of the Sun's motion, while in others the effect of the Sun's motion is negative instead of positive. If we take the whole number of stars whose observed proper motions lie between 0″·5 and 1″·0, these cannot be regarded as lying approximately between the same limits of distance from us. We know from their observed motions that in some cases the effect of the Sun's motion must be additive while in other cases it must be subtractive—that in one case the true proper motion is greater and in the other less than the observed proper motion, and that the difference between the real and the apparent motion is considerable. A better mode of proceeding seems to be this. Take say the 1000 stars whose observed proper motion is greatest. We know approximately, though not precisely, the number of those in which the effect of the Sun's motion is additive and subtractive respectively. Suppose the former to be 750 in number. Then, instead of using the 1000 stars with which we started as the basis of our computation, take also the 750 stars with

largest proper motion in which the solar effect is subtractive. We have, then, 1500 stars the real motions (and therefore the real distances) of which probably lie within the same limits, the effect of the Sun's motion being indicated by the larger amount of the proper motions in one list of 750 than in the other. Indeed a fair estimate of the effect of the Sun's motion might probably be made by comparing the proper motions (in R. A. and Decl.) of the last star in each list of 750 stars. Corrected proper motion affords a better indication of the real distances of stars than observed proper motion, even when the correction is a rough one. I may remark that when we find stars with motions resembling each other in the same region of the sky, then distances from us are not likely to be very different, and in such cases arithmetical limits of proper motion should not be relied on too strongly. Nor should a disagreement as to the motion in the line of sight receive too much weight. Binary stars are very numerous, and revolutions which observations in R. A. and Decl. are unable to reveal are often brought to light by the spectroscope We should make sure that the spectroscopic motion is not variable before concluding, on spectroscopic evidence, that two stars whose motions agree in R. A. and Decl. do not belong to the same group or family.

When I speak of the Sun's motion in space I do not intend to confound absolute with relative motion, or to deny that all observed or computed motion must be relative. But, as I have already indicated, there is an enormous number of extremely remote stars which appear to be motionless on account of their enormous distance. By the Sun's motion in space I mean his motion as referred to this back-ground of motionless stars. Their systematic motions, if they have any, are imperceptible and their position in the heavens will practically remain unchanged for centuries, so that systematic motions among the nearer stars will not affect the Sun's motion relative to them. But it is only by means of the stars whose motions we can measure that we can estimate the Sun's motion relative to this immovable back-ground. In this fact lies the chief difficulty of the problem.

MYTHS AND FANCIES OF THE MILKY WAY

By W. J. Wintemberg

Nor need we with a prying Eye survey
The distant Skies to find the *Milky way*,
It must be seen by *All*, for every night
It forcibly intrudes upon our sight.
—*Manilius: Astronomica.*

PRIMITIVE man everywhere has been a "watcher of the skies," and he could not fail to be early impressed with the grandeur and sublimity of this luminous band of stars; for there is perhaps nothing in the heavenly vault above us more calculated to arrest the attention and excite the wonder of man. The sight of it has given birth to several beautiful myths.

Notwithstanding the fact that in the early mythopœic ages the origin of nearly every object of nature was accounted for by some more or less mythological explanation, the ancients suspected that the whiteness of the zone was owing to a confluence of stars, which conjecture, it is scarcely necessary to say, was confirmed in Galileo's time. Manilius* alludes to this belief when he asks

Or is the spatious Bend serenely bright
From little Stars, which there their Beams unite,
And make one solid and continued Light?

And an Arabian poet, Ta'abbata Sharran, quoted in *Al Hamāsah*, an Arabic anthology, speaks of it as

The mother of clustered stars.

* Nothing definite is known about this poet. It is believed, however, that he flourished during the time of Augustus and Tiberius. He wrote a didactic poem, in five books, entitled *Astronomica* or *Poeticon Astronomicon*. I follow what is, I believe, the only English translation,—namely, *The Five Books of M. Manilius, containing a System of the Ancient Astronomy and Astrology: Together with the Philosophy of the Stoicks*, Done into English Verse with Notes by Mr. Tho. Creech, London, 1700. The quotations given are derived from Book I., xv.

According to Blake* it was believed by others to be "but an optical phenomenon produced by the reflection of the Sun's rays from the vault of the sky as from a mirror, and comparable with the effects seen in the rainbow and illuminated clouds. Metrodôrus says it is the mark of the Sun's passage which moves along this circle. Parmenides pretends that the milky color arises from a mixture of dense and rare air. Anaxagoras thinks it an effect of the earth's shadow projected on this part of the heavens, when the Sun is below. Democritus says it is the lustre of several little stars which are very near together, and which reciprocally illuminate each other. Aristotle believes it to be a vast mass of arid vapors which takes fire from a glowing tress, above the region of the ether, and far below that of the planets. Posidonius says that the circle is a compound of fire less dense than that of the stars, but more luminous."

Theophrastus (as well as Diodorus the Sicilian) claimed "it was the junction between the two hemispheres, which together formed the vault of heaven: and that it was so badly made that it let through some of the light that he supposed to exist everywhere behind the solid sky."† Manilius gives a poetical version of this belief as follows:

> Whether the Skies grown old, here shrink their frame,
> And through the Chinks admit an upper Flame,
> Or whether here the Heaven's two Halves are joyn'd
> But odly clos'd, still leave a Seam behind:
> Or here the parts in Wedges closely prest,
> To fix the Frame, are thicker than the Rest.
> Like clouds condens'd appear, and bound the Sight,
> The *Azure* being thickned into *White*.

Some of the Pythagoreans "assert that when Phaëton lit up the universe, one star, which escaped from its proper place, set light to the whole space it passed over in its circular course, and so formed the Milky Way."‡ Others believed it to have been caused by Phaëton himself, because he "could not rule his father's car of fire," and so, as Dante in his *Inferno* says, he

* *Astronomical Myths* (London, 1877), p. 151.
† *Ibid.*
‡ *Ibid.*

abandoned the reins,
Whereby the heavens, as still appears, were scorched.

There is also an allusion to this in Longfellow's *The Galaxy*:

Phaëton's wild course that scorched the skies
Where'er the hoofs of his hot coursers trod.

Although it has many other titles and mythical associations it is most widely known as the Galaxy or Milky Way (the *Via lactis*, *Via lactea*, and *Semita lactea* of the Romans, the *Via lattea* of the Italians, the *Voie lactée* of the French, the *Melkpath* of the Frisians, and the modern *Milch Strasse* of the Germans). The Hebrew word *Mazzārōth*, some Rabbis positively assert, has a like signification; and so also have the Arabic *Al Majarrah* and *Tarīk al Laban*. As appears from the following lines from the *Shi-King*, written by King Seuen on the occasion of a great drought, even the ancient Chinese knew it by this name:

Grand shone the Milky Way on high,
With brilliant span athwart the sky,
Nor promise gave of rain.*

Curiously enough, the Micmac Indians call it by a name which signifies the same.† Aratus speaks of it thus:

A radiant girdle belts the azure sky—
. . . . . .
The Milky Zone;‡

which someone else, I believe, has rendered,

that shining wheel, men call it Milk.

Plutarch, who believed also that it was a nebulous circle, claimed that it "owes its name to its white appearance."§

Nearly everyone familiar with classic mythology knows how one Greek myth accounts for the Milky Way—it is the story of Hera and the infant Heracles. Heracles, so the story goes, was taken from his mother Alcmena at his birth, and carried to the breast of the sleeping Hera, who, when she awoke, indignantly

* Part III., book iii. (Legge's translation).

† Rand's *Legends of the Micmacs* (New York and London, 1894), p. xli., Intro.

‡ *The Phenomena and Diosemeia of Aratus*, translated by John Lamb, D.D. (London, 1848), line 480 *et seq.*

§ Blake, *op. cit.*

pushed the child from her, spilling the milk over heaven, which resulted in the Galaxy (*γάλα, γάλακτος*, "milk"), and thus it

> justly draws
> Its name, *the Milky Circle*, from its Cause,

as the translator of Manilius quaintly puts it. The early Hindús are said to account for it in a somewhat similar way in connection with Saramā. (This, according to the interpretation of the solar mythologers, is the red cow of evening passing during the night across the sky, scattering her milk).* Greek writers, from the above circumstance, therefore knew it as *Κύκλος γαλακτικός*, the "Galactic Circle"; Eratosthenes called it *Κύκλος Γαλαξίας*, "the Circle of the Galaxy"; Hipparchus, *ὁ Γαλαξίας*; and Anaxagoras and Aratus, *τὸ Γάλα*. Pliny, likewise, following Cicero (who also called it *Orbis lacteus*), knew it as *Circulus lacteus*.

The Hidatsa Indians† and the Eskimo call it the "ashy way" or the "ashen path,"‡ and in an "African myth it is some wood ashes long ago thrown up into the sky by a girl, that her people might be able to see their way home at night."§ Manilius' lines

> this was once the Path
> Where *Phœbus* drove; and that in length of Years
> The heated track took Fire and burnt the Stars.
> The Colour changed, the Ashes strew'd the Way,
> And still preserve the marks of the Decay,

show that the ancients had a similar belief. This idea of the stars being burnt by the continual passing of the sun-god's chariot no doubt also gave rise to the title *Via perusta* and to Macrobius' *Zona perusta*, the "Girdle Burned."

"With the Kiowa, Cheyenne and plains tribes the Milky Way is the dusty track along which the Buffalo and the Horse once ran a race across the sky."‖ The Ottawa Indians say it

* Clodd's *Birth and Growth of Myth*, vii., p. 14.
† *11th Ann. Rep. Bur. Am. Ethnology*, p. 517.
‡ *Star Names and their Meanings* (New York, 1899), p. 477.
§ Clodd, *op. cit.*
‖ "Myths of the Cherokee," *19th Ann. Rep. Bur. Eth.*, p. 443.

was caused by a big turtle swimming along the sky and stirring up the mud at the bottom.* As the culture heroes of primitive peoples figure quite prominently in their nature myths we need not be surprised to hear that one of them made the Milky Way. Among the Behring Strait Eskimo, for instance, the Raven is said to have been the Creator, and the Milky Way is the track made by his "snowshoes when he walked across the sky during one of his journeys while creating the inhabitants of the earth."† The Cherokee Indians, according to Stansbury Hagar, have a story which accounts for it in this wise: "Once there were two hunters. One lived in the North and hunted big game, the other lived in the South and hunted small game. The former became jealous of the latter and one day he, Hunter of Big Game, perceiving Hunter of Little Game's wife grinding corn into meal, seized and carried her away from the corn beating place far across the sky to his home. Her dog ate the meal that was left, then followed the pair across the sky, and the meal fell from his mouth as he ran, forming a trail of meal."‡ In another Cherokee myth, given by Mooney, it is the track left by a wicked dog who dragged across the sky something (some say it was meal) he had stolen, and it is known to this day by a name which signifies "Where the dog ran."§ Following up what a folklorist might call the "theft theme" a little further, we find that, according to an Eastern myth referred to by Clodd, "it is chaff dropped by a thief in his hurried flight."‖ Many Semitic names of the Galaxy seem to run on this scattered chaff dropped by the thief. The Modern Hebrew *Netibat theben* is one of these names and means the "Chaff Path." The Syriac and Turkish titles have the same meaning. In a Wallachian fairy tale the Milky Way is said to come from the "*Split Straw* that Saint Venus (Vinire) has stolen from Saint Peter"¶ and which she dropped

* Clodd, *op. cit.*

† "The Eskimo about Behring Straits," *18th Ann. Rep. Bur. Eth.*, p. 449.

‡ *Stellar and Magic Legends of the Cherokees*, etc., from the late R. G. Haliburton's MS. copy.

§ "Myths of the Cherokee," p. 257.

‖ *Op. cit.*

¶ Grimm, *Teutonic Mythology* (Stallybras trans.), Vol. IV., p. 1389.

in her flight; and this, some say, gave her the Armenian title of *Hartacol*, or *Hartacogh*, the "Straw Thief." There is a similar story in classic folk-lore. Isis, fleeing from Typhon, drops some corn leaves, and these become the Milky Way. These stories lead us to other titles almost similar in meaning. The Arabic names were *Darb al Tābānīn*, the "Path of the Chopped Straw Carriers"; *Derb ettübenin*, meaning the same; and *Tarīk al Tibn*, the "Straw Road." Crooke says "The Persians call it *Kahkashán*, the dragging of a bundle of straw through the sky."* Grimm and Allen give the Coptic and Ethiopian designations, which have a like signification. In China it was known as the "Yellow Road" from the color of this scattered straw.

In an age when popular heroes and demi-gods were commonly translated to heaven it was quite natural to also liken this celestial girdle to natural and other features occurring on the earth. Thus, from time immemorial, it has been known as "the River of Heaven" or of the sky. In Egyptian mythology it was "the inaccessible stream."† The Euphratean name was "the River of the High Cloud."‡ To the Akkadians it was the "Snake-River," "River-of-the-Cord-of-the-God-great," "River-of-the-Abyss-great," "River-of-the-Shepherd's-hut, dust cloud high," "River-of-the-Divine-Lady," and the "River of Nana," the wife of the Heaven-god.§ The Arabs called it *Al Nahr*, which signifies "the River," and it was known to the Hebrews as *Nɛhar di Nur*, "the River of Light." In China, as well as in Japan, it was *Tien Ho*, the "Celestial River" and "the Silver River, whose fish were frightened by the new moon, which they imagined to be a hook."‖ Among the Hindús of Northern India it is known as the "course of the Heavenly Ganges."¶

* *Popular Religion and Folk-Lore of Northern India*, Vol. I., p. 25.

† *Book of the Dead*, cap. xcviii.; *apud* Brown, *Primitive Constellations*, Vol. II., p. 75.

‡ *Primitive Constellations*, Vol. II., p. 204.

§ *Ibid.*, *passim* ref.

‖ Allen, *op. cit.*, p. 475.

¶ Crooke, *op. cit.*, p. 25.

In a Sanscrit legend, according to Al Bīrūnī, it is called the "Bed of the Ganges." It was also long known as Eridanus, the "Stream of Ocean." Another ancient name for it was the "Canal" of the sky.* The Sauks and Fox Indians call it the "White River."†

But perhaps one of the most common conceptions of the Milky Way is as a road or pathway. In Grimm's *Teutonic Mythology*‡ we find many such names, of which some have already been given above. The Northmen knew it as *Wuotanes Wec*, or *Strâza*, "Woden's Way," or "Street"; and *Vetrarbraut* or "Winterway." In Westphalia it was known as *Wiärstrate* or "Weather Street." Among the Midland Dutch it was *Vroneldenstraet = frauen Hilde*, or *Hulde*, *Strasse*, woman (or Saint?) Hilda's, or Hulda's, street or highway. In Jutland it is *Veiervein*, or *Brunel*, *Straet*. The people of East Friesland call it *Harmswith*. "In a Westphalian folktale picked up by Kuhn, giants call to *Hakelberg* for help, he raises a storm, and removes a mill into the Milky-Way, which after that is called the *Millway*,"§ *i.e.*, *Mülen-weg*.

Among the Germans it is also known as *Jakob's Strasse*, or *Weg*, that is, "Jacob's Road." Another name for it is "Jacob's Ladder."

To the Hungarians, according to Grimm, it was known as "*Hada-kutya* (Via belli) because the Hungarians in migrating from Asia, followed this constellation."‖

The Celts knew it as *Arianrod*, the "Silver Street,"¶ and the Swedish peasant has beautifully named it *Vintergata* or "Winter Street," of which Miss Edith M. Thomas has written the following beautiful lines:

* Brown, *op. cit.*, Vol. I., p. 103.

† *Journal of American Folk-Lore*, Vol. XIV., p. 237.

‡ Chiefly at p. 357, Vol. I., (*footnote*), and p. 1389, Vol. IV.

§ *Ibid.*, Vol. IV., p. 1588.

‖ *Ibid.*, Vol. I., p. 357.

¶ *Ibid.*

Silent with star-dust, yonder it lies—
The Winter Street, so fair and so white;
Winding along through the boundless skies,
Down heavenly vale, up heavenly height.

Faintly it gleams, like a summer road
When the light in the west is sinking low,
Silent with star-dust! By whose abode
Does the Winter Street in its windings go?

And who are they, all unheard and unseen—
O, who are they, whose blessed feet
Pass over that highway smooth and sheen?
What pilgrims travel the Winter Street?

Are they not those whom here we miss
In the ways and the days that are vacant below?
As the dust of that Street their footfalls kiss
Does it not brighter and brighter grow?

Steps of the children there may stray
Where the broad day shines though dark earth sleeps,
And there at peace in the light they play,
While some one below still wakes and weeps.

In prosaic contrast to this we find that in England it was called "Watling Street," after that famous highway which ran from Chester through London to Dover; but why this name should be transferred to the sky we do not know. It is alluded to by several old authors, foremost among whom is Chaucer. In his *Hous of Fame* he says:

Lo there, quod he, cast up thine eye,
se yondir, lo, the galaxie,
the whiche men clepe the milky way
for it is white, and some parfray
ycallin it han *Watlingestrete*,
that onis was brente with the hete,
whan that the sunnis sonne the rede,
which hite Phaeton, wolde lede
algate his fathir's carte and gie.*

In the *Complaint of Scotland*, in speaking of a comet, it is said that "it aperis oft in the quhyt circle callit circulus lacteus, the quihilk the marynalis callis Vatlanstreit."†

*II., 427. It will be noted that the latter part of this quotation also mentions the Phaëton episode adverted to above.

† *Apud* Grimm, Vol. I., p. 356.

It was also known as "Walsingham Way," and was supposed to guide pilgrims to the shrine of the Virgin Mary in Walsingham, Norfolk. Another name, found in Anglo-Saxon glossaries, and cited by Allen, is "*Iringes Ueg*, *Weg*, or *Wec*, Iringe's Way," as is also "*Bil-Idun's* Way."* In Denmark it is called "Waldemar's Way." This was Waldemar the Victorious, who substituted the Danebrog for the national banner of Denmark. For centuries the common English name was the "Way of Saint James." With the French peasantry it is *Le Chemin de Saint Jacques de Compostella*. This, in the ever musical Spanish, becomes *El Camino de Santiago*, the patron saint in battle of Spain, to whom Longfellow refers in *The Galaxy*:

> The Spaniard sees in thee the pathway, where
> His patron saint descended in the sheen
> Of his celestial armor, on serene
> And quiet nights, when all the heavens were fair.

Among the Mexicans it is also known as the road of Santiago, and is "guarded by three sentinels—the belt of Orion."†

The Turks called it *Hadjiler Juli*, the "Pilgrims' Path."‡ In mediæval ages it was known as "the Way to Rome" (the Swiss *der Weg uf Rom*,§ the Italian *Strada di Roma*, and the *Zesta v' Rim* of the Slovak), because it was only through Rome, the capital of the church, that access to heaven could be secured.

The Hindús of Northern India, according to Crooke, knew it as *Nâgavithi*, or "the path of the snake"; and "To the Panjâbi," the same authority states, "it is known as *Bera dâ ghâs* or the path of Noah's Ark."‖

Much cruder conceptions prevailed among the American Indians,—the Patagonians, for instance, thinking that it is the road on which their departed friends are hunting ostriches. The Kootenay Indians call it the "Dog's Trail,"¶ and the Blackfeet, we learn from Grinnell, knew it as the "Wolf Road."**

* Allen, *Star Names*, p. 478.

† "Superstitions of the Rio Grande," *Jour. Am. Folk-Lore*, Vol. VII., p. 129.

‡ Grimm, Vol. I., p. 357. § *Ibid.*, Vol. IV., p. 1389. ‖ *Op. cit.*, p. 26.

¶ Dr. A. F. Chamberlain in *Ontario Archæological Report* for 1905, p. 186.

** *Blackfoot Lodge Tales* (New York, 1892), p. 102.

The Finns call the Milky Way *Linnunrata*, or "the Birds' Way"; "perhaps," as Grimm explains, "because souls and spirits flit in the shape of birds," or, as Allen says, "because the united bird-songs were turned into a cloud of snow-white dovelets still seen overhead." The Lithuanian *Paukszczių Kielis* has the same meaning. Grimm says the Lettic name is *Putnu zel-s-ch*, which means "the Bird path."

In both the Milky Way and the rainbow early man saw the ladders, bridges, and ways whereby the departed spirits pass from earth to heaven—or, as among our own Red Men, the spirits' road to the happy hunting grounds. Indeed, even the poets have with common consent called it the pathway of departing souls, or

> The way to God's eternal house,

as Milton said.* In the Indian's belief, as given in the beautiful lines of Longfellow, it is

> the broad, white road in heaven,
> Pathway of the ghosts, the shadows,
> Running straight across the heavens,
> Crowded with the ghosts, the shadows.†

This idea is also embodied in Hayne's *Indian Fancy*:

> Pure leagues of stars from garish light withdrawn
> Behind celestial lace-work pale as foam,—
> I think between the midnight and the dawn
> Souls pass through you to their mysterious home.

In Pawnee Indian star lore "The Milky May is the path taken by the spirits as they pass along, driven by the wind which starts at the north to the star in the south, at the end of the way." They also say that "As most people linger in their death through sickness, so the path they dread is the long path we see across the sky, while the short path (the short fork of the Milky Way) is the path made by those whose life is cut short by sudden death, as in battle."‡

* *Paradise Lost*, vii., 576.

† *Hiawatha*, iii.

‡ *Jour. Am. Folk-Lore*, Vol. XVI., p. 13.

Sagard tells us that among the Huron Indians "They believe the souls immortal: and leaving the body, that they go immediately to dance and to enjoy themselves in the presence of *Yoscaha*, and of his grandmother *Atensiq*, taking the route and path of the stars, which they call *Atiskein andahatey*, the path of spirits. . . . . They say also that the spirits of dogs go there too, taking their route by certain stars, which are close to the road of spirits [qui sont proches voysines du chemin des ames, in the original], and which they term *Gagnenon andahatey*, that is to say, the 'way of the dogs.'"*

Milton's well-known lines,

> A broad and ample road, whose dust is gold,
> And pavement stars, as stars to thee appear
> Seen in the galaxy, that milky way
> Which nightly as a circling zone thou seest
> Powder'd with stars,†

remind us of Ovid's, who, no doubt on account of its lustre, represents the Milky Way as the high-road to heaven, or the court of Jupiter; he says:

> A way there is, in Heav'n's expanded plain,
> Which, when the skies are clear, is seen below,
> And mortals by the name of milky, know.
> The ground-work is of stars; through which the road
> Lies open to the thunderer's abode.‡

So, too, to the early Hindús, the *Rig Veda* tells us, it was "the God's Path," or the "Path of Āryamān," leading to his throne in Elysium. Another Hindú name, according to Crooke, is "the Door of Paradise." Scandinavian myth makes it the road to Valhalla—the palace of their heroes slain in battle. In the *Edda*, it may be observed, the rainbow is the heavenly road over which the gods pass; but it is sometimes doubtful whether it or the Milky Way is referred to. One passage in particular (cited by Keary§), where Helgi says to his wife,—

> "'T is time for me to ride the ruddy road,
> And on my horse to tread the path of flight,"

* Sagard: *Le Grand Voyage du Pays des Hurons*, etc., Paris, 1632 (new edition, Paris, 1865), p. 233.

† *Paradise Lost*, vii., 577, *et. seq.*

‡ *Metamorphoses*, Book I. (Dryden's translation).

§ *Mythology of the Eddas* (London, 1882).

seems to be more applicable to the Milky Way than the rainbow.

The Galaxy has also been known as the "Asgard Bridge." Asgard was the abode of the gods, and access to it was gained only by crossing the bridge *Bifrost*, the rainbow, which itself had the title of "Asgard Bridge"; and the Milky Way likewise being popularly regarded as a bridge, the above name later was applied to it and *Bifrost* indiscriminately.

The late Zachris Topelius, the Finnish poet and dramatist, in one of his poems represents it as the

> starry bridge of light,
> Which now smiles down upon the earth from heaven's placid face,
> And firmly bands together still the shores of boundless space.

Two lovers (Zulamith and Salami) built this bridge so that they might be united in heaven as they had been on earth, and when they had accomplished their task they were merged together in the star Sirius. Another verse tells how

> They toiled and built a thousand years
> In love's all powerful might:
> And so the Milky Way was made—
> A starry bridge of light.*

In Northern India, we learn from Crooke, it is called "the Court of God." To the Celts it was known as "the castle of Gwydion, after one of the sons of the god Don, who dwelt there."† It was called "the town of Gwyon" according to Blake.‡ Allen says "the Celts also thought it the road along which Gwydyon pursued his erring wife."§ In Scandinavian mythology Balder and his wife Nanna live in the palace *Breidablik* ("wide-shining") amid the Milky Way. Along this road, according to classic belief, stood "the palaces of the illustrious gods; the common people of the skies live apart, on either side."‖ In a legend of the Saux and Fox Indians a manitou has his lodge on the White River. I have read somewhere that the Egyptians thought heaven to be on many islands at the foot of

* *Apud* Allen, p. 483.
† Clodd: *Childhood of Religion.*
‡ *Astronomical Myths*, p. 40.
§ *Op. cit.*, p. 481.
‖ Bulfinch: *Age of Fable*, chap. ii., p. 16.

the Way. According to a belief of the Australian aborigines it is a sort of paradise of souls; and this last reminds us of the classical Manilius'

> *Souls* which loosed from the ignoble Chain
> Of Clay, and sent to their own Heaven again,
> Purg'd from all dross by Vertue, nobly rise
> In *Æther* wanton, and enjoy the Skies.

Other names have been given to the Galaxy. In ancient Rome it was known as *Cœli Cingulum*, "the Heavenly Girdle." Another Roman title was *Circulus Junonius*. The Letts, according to Grimm, name it *Deeva yahsta*, that is, "God's Girdle."* A common French appellation in Sagard's time (*circa* 1632) was *l' escharpe estoilée*, or "the starry belt," and this is like the Modern German *Sternengürtel*. The "Crooked Serpent," (the "swift serpent" in the Revised Version) mentioned in the *Book of Job* (xxvi., 13), is by Rabbi Levi considered to refer to the Milky Way. To the Polynesian Islanders it is known as the "Long, Blue, Cloud-eating Shark," a singularly inappropriate name to be sure. English sailors call it "the White Strip."† I have heard it called the "Mare's Tail"—erroneously, of course, for this is an entirely different phenomenon.

Among the Hindús of Northern India the Milky Way is regarded as one of the "godlings" of nature.‡

The Incas of Peru called it the "dust of stars."§

It even has a place in the popular weather lore of the people. Germans say that when the Galaxy is unusually bright it is a sign of approaching cold weather. The Chinese, also, seem to have regarded some changes in its appearance as prognostications of rain, for we find that King Seuen, in the quotation from the *Shi-King* given above, was lamenting that it gave no promise of rain.

* Grimm, Vol. IV., p. 1389.

† "Weather Lore of the Sea," *Folk-Lore* (London), Vol. II., p. 482.

‡ Crooke, *op. cit.*

§ "Astronomy of the Incas," *Popular Science Monthly*, October, 1894.

NOTES ON DOUBLE STARS

h 2117 a variable double star—Σ 599—Swift—h 2770—Espin 187—Some New Pairs.

By T. E. Espin

(1) *h* 2117, R. A. $2^h\ 4^m\ 40^s$, DECL. + 44° 6′ (1880).

HERSCHEL speaks of this star as "quadruple, the others 14 mag." It first came under my observation in 1908, Jan. 7, when I measured it; on Jan. 11, to my surprise, I found the magnitudes of *A* and *B* reversed; on Jan. 18 the stars were again as at the first observation. I then commenced observations of them each night. The following are the results:—

1908	January	7		*A* 9·5	*B* 9·7
		11		9·5	9·3
		18		9·5	9·7
		21		9·5	9·7
		24		9·5	9·7
		28	6h 0m	9·5	9·2
		29	6 0	9·5	9·7
		30	7 30	9·5	9·7
		31	7 30	9·5	9·6
	February	1	6 0	9·5	9·4
		3	6 30	9·5	9·7
		4	7 0	9·5	9·3
		5	7 30	9·5	9·7
		6	6 45	9·5	9·2
		7	6 30	9·5	9·6.

Throughout *A* has been called 9·5, and the variation supposed to be in *B*. Either may be variable, and it seems very probable that the period is a short one. The results of the measurements are as follows:—

A B	1908·04	*P.*	30°·1	*D.*	8″·00	3nt.	
A C			199·8		13·17	3nt.	*C* = 10·4
A D			285·3		24·43	3nt.	*D* = 11·7.

(2) Σ 599.

I noticed on Jan. 29 a faint *comes* which I attempted to measure. From Professor Burnham's latest measures which have just been received, he had already detected it and measured its position from *A*. My results are :—

A B	1908·08	*P.* 335°·3	*D.* 9″·83	3nt.	Mags. 8·0 9·0
B C	1908·08	67°·2	14″·55	3nt.	*C* = 14·0.

C is a difficult object to measure with the 17¼ in. reflector.

(3) SWIFT, R. A. $13^h\ 57^m\ 40^s$, DECL. +46° 55′ (1880).

Some quite easy pairs are very tiresome to measure, when they are anywhere near 0° or 180°. This star is a very good example, and I give the results as showing how divergent carefully made observations may be :—

1908,	May	2	*P.* 8°·2	*D.* 2″·30
		18	9°·6	2″·75
		21	6°·3	2″·65
		23	3°·2	2″·40
		27	10°·0	2″·50.

The following are all the measures of this pair that I know of :—

J	1889·39	*P.* 6°·7	*D.* 2″·44	2nt.	Mags. 9·0 9·0
A	1897·55	5°·5	2″·52	3nt.	
Es.	1908·36	7°·5	2″·52	5nt.	9·0 9·1.

(4) *h* 2770, R. A. $15^h\ 8^m\ 55^s$, DECL. +47° 18′·5. (THE PLACE HERE GIVEN WAS REDETERMINED FROM Σ 1920).

On May 19 I found that *A* was double. The measures were made in twilight which, at that time of the year is here bright throughout the night and the results are not very accordant :—

A B	1908·38	*P.* 49°·6	*D.* 2″·30	3nt.	Mags. 10·0 10·1
A C	1908·38	129°·4	16″·57	2nt.	*C* = 10·5.

(5) ESPIN 187, R. A. $18^h\ 20^m\ 57^s$, DECL. +51° 36′ (1880).

Quite lately I have found an observation of Argelander's in Vol. VI. of the *Bonn Observations* made in 1862 where this star

is entered as "Dpl. I. Class." This year I have connected it with a 9·0 mag. star in the field and subsequently found that Argelander had measured this star with the heliometer (*Bonn Observations*, Vol. VI., p. 367). Argelander's observations settle both the question of the physical connection of the close pair and give us a new determination of the proper motion. The following are all the observations of the star I know of :—

A B	Argelander	1862·62	8·7 8·7	3″±	
	Espin	1903·76	*P* 198°·7	*D.* 2″·79	4nt
	β	1905·66	201°·3	2″·40	2nt.
	Espin	1908·50	202°·40	2″·40	4nt.

Using the differences in R. A. and Decl. from the heliometer observations we have :—

A C	Argelander	1864·90	*P.* 114°·5	*D.* 82″·52	
	Espin	1908·48	118°·6	85″·44	3nt.

The P. M. of the pair as given in the *Harvard Observations* and the new determination are as follows :—

Harvard	0″·103 at 300°
Espin	0″·153 " 358°·9.

The following are some new pairs lately detected :—

B D	R. A. 1880	Decl.	*P.*	*D.*	Mags.	Nights	Date
°	h m	° ′	°	″			
+52°1959	16 16·8	+52 3	265°·7	3″·37	8·9 12·0	2	08·47
+42°2783	57·8	42 54	258°·9	6″·30	7·0 11·5	2	·41
+52°2083	17 35·5	52 40	114°·7	2″·53	8·7 10·2	3	·48
+53°2011	57·6	53 16	340°·3	4″·75	8·7 9·2	2	·56
+53°2054	18 11·3	53 39	88°·8	2″·75	8·2 12.0	3	·56
+54°2152	19 25·5	53 43	191°·2	7″·60	7·1 12·5	3	·64

TOW LAW, ENGLAND,
September 8, 1908.

LAKE UNDULATIONS

By F. Napier Denison

I HAVE been greatly interested in reading two illustrated articles upon the "Tides of Lake Huron" by Mr. W. J. Loudon, published in the JOURNAL of our Society*; and having obtained continuous records of the undulations upon Lake Ontario, I take the liberty of presenting the following notes which may tend to prove the true cause of the long-period undulations recorded upon both lakes.

During the summer of 1896 the writer was much interested in noting, upon the eastern shore of Lake Huron, small changes of water level in short intervals of time; and later, by permission of Mr. Stupart, Director of our Meteorological Service, I constructed a simple hydrograph and set it up at the mouth of the Humber River near Toronto.†

The records from this instrument clearly demonstrated the presence of a number of different types of undulatians. By comparing these curves with those of a sensitive barograph for the same periods of time a marked correspondence was found to prevail. That is, when the barograph trace was most disturbed the amplitude of the lake undulations was greatest. The results of this investigation formed the subject of a paper entitled "The Great Lakes as a Sensitive Barometer" read at a Canadian Institute Meeting, February 6th, 1897, also at the British Association Meeting held in Toronto of the same year.

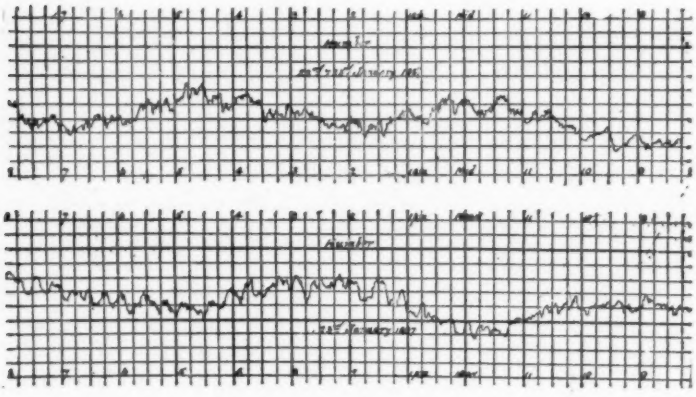
The Majority of these undulations come under the term of "Seiches," which name was first used by investigators upon the Swiss Lakes many years ago.

Apart from the smaller and more rapid undulations, the writer has upon several occasions obtained clear records of the

* Vol. I., p. 181; Vol. II., p. 82. (Refer also to *Transactions* for 1905, p. 131.—Ed.)

† Described in the *Monthly Weather Review* for May, 1897.

longitudinal and transverse "seiche" movements of Lake Ontario. The late Lord Kelvin has given us a theoretical law for determining the duration of these undulations in any lake. (*Archives des Sciences Naturelles*, Geneva, 1876). Thus the duration of a longitudinal "seiche" is proportional to the length of the lake and inversely proportional to the square root of its mean depth. Applying this to Lake Ontario we obtain a theoretical duration for a longitudinal "seiche" of about five hours. The record shown in the accompanying figure is a good example of the amplitude and time intervals obtained during and after the passage of great differences of barometric pressure over the lake's surface, and it shows a marked longitudinal "seiche" of four hours and fifty minutes, and an amplitude of three inches.



The above represents an actual record taken at the Humber during a heavy north-westerly gale, which graphically shows not only the smaller fluctuations as already referred to, but the longitudinal and transverse "seiche" which only occur during great atmospheric disturbances. The latter are caused by the water being raised at the east end of the Lake, primarily due to the differences of atmospheric pressure between the extremities of the same, and greatly augmented when the gale strikes the water's surface. This tends to set up a movement of oscillation both longitudinal and transverse, as explained by Professor Forel; the former having an amplitude of about 3 inches, and a mean time interval of 4 hours and 49 minutes, and the latter an interval of 45 minutes.

I have taken Mr. Loudon's published records and studied them with the synoptic weather charts for the same periods, and am strongly of the opinion that the long undulations of approxi-11 hours duration are not due to lunar action, but to differences of barometric pressure prevailing over the surface of Lake Huron.

If we compare the relative dimensions of these two lakes we find that Ontario is about 193 miles long by 53 wide with an area of 7,260 square miles, while Lake Huron is 207 miles by 101 with an area of 23,000 square miles. We may therefore expect to find a longitudinal "seiche" with a time interval as great as 11 hours. It is interesting to note that these long-period undulations are well defined upon all the records published by Mr. Loudon, except the one for August 15th, 1906, which he states is remarkable, as this period was one of dead calm and preceded by a long interval of comparative calmness.

By turning to the weather chart for 8 A.M., August 15th, 1906, we find an extensive high barometer area centred over the Lake Region and the actual difference of air pressure prevailing over Lake Huron was practically nothing, while on the preceding day the difference was only about 0·05 barometric inch. From a careful perusal of the weather charts for the dates when Mr. Loudon obtained the long-period lake undulations, I find that these are noticeable when there is only a difference of 0·10 barometric inch. It appears that the amplitude is more pronounced when the difference of air pressure is as much as 0·20 inch, and that when this great body of water is once set in motion these undulations continue for hours after the disturbing cause has passed, and apparently no difference of air pressure is noticeable over the lake's surface. Referring to Lake Ontario these longitudinal "seiches" are not noticeable, except during greater differences of air pressure prevailing over the lake's surface. This is probably due to the much smaller area of Lake Ontario.

Respecting the lunar tidal action the writer was enabled to detect this type of undulation during settled weather conditions which often occur during the summer months. It is to be hoped

that Mr. Loudon may in the near future be enabled to obtain continuous records from his hydrograph on Lake Huron for one year, when not only will the true lunar tidal action be well defined during settled weather but many interesting types of undulations be clearly defined, such as the longitudinal and transverse "seiches," which doubtless occur during the passage of the great winter cyclonic areas across the Great Lake Region.

VICTORIA, B. C.

NOTE TO MR. DENISON'S PAPER

BY W. J. LOUDON

WITH regard to the foregoing paper of Mr. Denison and his statement that the undulations observed by me may be due to, change of barometric pressure, I can only say that in the *Transactions* of 1905 I pointed out that the most convincing evidence of lunar tidal action on Lake Huron was deduced from the set of three records which I obtained in September–October of that year. The "lagging" of the Moon's action is so clearly evident in these records that I do not see how any one can have doubts on the point.

If Mr. Denison has not seen these three records I hope he will inspect them as soon as possible. I may say that I hope to have a number of records soon, both from Lake Ontario and Lake Erie, which will perhaps assist in clearing up this question of tidal action.

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA

By J. S. Plaskett

THE recent meeting of the Society at Hotel Victory, Put-in-Bay Island, Lake Erie, August 25, 26 and 27, was a most successful and enjoyable one. Previously the meetings had usually been held in a large city during the Christmas vacation, but some of the members thought it would be desirable to try holding the meeting in the summer time and at a place where all the members could live under one roof. In a large city the members are inevitably scattered to different hotels, thus preventing that social intercourse and opportunity of informally discussing questions of mutual interest which, in the opinion of many, without underrating the value of the papers presented, are the chief advantages to be derived from membership in the Society.

The experiment undoubtedly proved successful and I am sure all the 25 or 30 members present will agree in the statement that the social side of the gathering was much enhanced by all living together in one house. Even if there had been no other chance of meeting and talking in a friendly way, the exceeding leisureliness of the service in the dining room, where the members were grouped together at three or four adjoining tables, compelled them to spend, besides the time in the meetings, at least four hours each day together, thus cultivating that spirit of friendliness and good fellowship which was so marked a feature of the meetings.

Then, too, the weather was delightful during the week of the meeting and the surroundings pleasant. Put-in-Bay is a very pretty spot, just the place for a summer holiday. Besides the natural beauties and resources of the Island, it possesses three or four exceedingly well-advertised caves, which some of the more venturesome and wealthy (?) of the members visited, most of them, however, being content with the report of the explorers.

It was even rumored that, not satisfied with the scenery, some of the older members were absenting themselves and indulging in flirtations with some of the fair inhabitants,—but this must be scandal.

In the programme following, issued previous to the meeting, there appear the titles of 20 communications and 13 papers.

PROGRAMME.

COMMUNICATIONS.

1. David Todd: Why are the longitudes of the north poles of the planets approximately the same as their longitudes of perihelion? (5 minutes).
2. Asaph Hall: Formulas used for the reduction of satellite observations (10 minutes).
3. G. W. Hough: Doolittle's measures of the Hough double stars. (10 minutes).
4. W. S. Eichelberger: The standard clock of the U. S. Naval Observatory. (5 minutes).
5. C. L. Doolittle: Illumination of the reflex zenith tube. (10 minutes).
6. E. E. Barnard: On the period of the variable star *M* 5 (No. 33) and on the constancy of the period. (10 minutes).
7. David Todd: Who first discovered canals on Mars and gave them that appellation? (5 minutes).
8. Charles Lane Poor: The photoheliometer. (10 minutes).
9. R. H. Curtiss: A possible third body in the system of Algol. (10 minutes).
10. E. D. Roe, Jr.: Achromatic and apochromatic. Comparative tests. Preliminary communication. (10 minutes).
11. E. E. Barnard: On a quick visual method of correcting for the changes of focus in the large visual telescope when used for photography with a color-filter. (10 minutes).
12. E. E. Barnard: On the focal changes in the image of *Nova Persei* and on the focus for some of the Wolf-Rayet stars. (10 minutes).
13. G. C. Comstock: Approximate ephemerides of the fixed stars. (10 minutes).
14. E. C. Pickering: A new form of stellar photometer. (10 minutes).
15. E. C. Pickering: Standard photographic magnitudes. (10 minutes).
16. Frank Schlesinger: On the character of the light variations of *u Herculis*. (10 minutes).
17. J. A. Parkhurst: Light curve of the variable star *SU Cassiopeiæ* from extra-focal photographs. (Lantern). (10 minutes).
18. E. E. Barnard: On the inequalities in the proper motion of the star Krueger 60, due to orbital motion. (Lantern). (10 minutes).

19. J. S. Plaskett: The cœlostat telescope of the Dominion Observatory. (Lantern). (10 minutes).
20. J. S. Plaskett: Camera objectives for spectrographs. (Lantern). (10 minutes).

PAPERS.

1. Philip Fox: Prominences on the solar disk. (Lantern). (15 minutes).
2. Milton Updegraff: The work of the Nautical Almanac Office. (15 minutes).
3. G. W. Hough: On an infinite universe. (15 minutes).
4. G. C. Comstock: The luminosity of the brighter lucid stars. (15 minutes).
5. Frank Schlesinger: Photographic determinations of stellar parallax with a large refractor. (15 minutes).
6. Joel Stebbins: The measurement of starlight with a selenium photometer. (15 minutes).
7. Edwin B. Frost: Spectrographic observations. (12 minutes).
8. Charles Lane Poor: The figure of the Sun and possible variations in its size and shape. (20 minutes).
9. F. H. Seares: Results of photometric investigations. (20 minutes).
10. W. T. Carrigan: An investigation of terms in the mean longitudes of Mars and the Earth, that have the argument, $3J - 8M + 4E''$. (20 minutes).
11. W. J. Humphreys: The temperature gradient of the atmosphere and an attempt to account for the upper inversion. (20 minutes).
12. J. S. Plaskett: Effect of increasing the slit-width upon the accuracy of radial velocity determinations. (20 minutes).
13. Raymond S. Dugan: The Algol System, *RT Persei*. (20 minutes).

The distinction between communications and papers lies simply in the time required for presentation, the former being supposed to occupy ten minutes or less, the latter more than ten minutes. If this classification had been strictly adhered to some of the communications would have been papers and some of the papers might have been communications. Five of the communications (Nos. 1, 7, 8, 9 and 15), and one paper (No. 8) were not read, while one additional paper, by Prof. W. W. Campbell on the "Total Eclipse of January, 1908," was read by Professor Hussey. All the papers read were of high class, several of them being marked by the importance of the results and conclusions

reached, showing a distinct advance over previous work in the same line, and the work of the meeting of 1908 is certainly not inferior to that of previous meetings. In addition to the value of the results obtained, the matter of the papers was presented in such a clear and simple manner as to enable every one, even in work along an entirely different line from that which he had been following, to fully grasp and understand it. As abstracts of all the papers read will appear in *Science* I will not attempt here to say anything of any of them, especially as those I remember most distinctly may not have been the most important, but only those in the line of work in which I was most interested.

The members present at this meeting were faithful in their attendance at the sessions and certainly put in a strenuous time reading and discussing papers. The sessions lasted about three hours each in the morning and afternoon, with an evening session on Wednesday for the papers requiring lantern illustrations. The evening session, outside the interest and value of the papers, was most marked by the extreme badness of the hotel projection lantern. The illuminant, a 100 c. p. incandescent lamp, was too weak, and the objective had such a strongly curved field that only a spot in the centre of the picture, about one-quarter its diameter, could be made sharp. It was suggested by the author of a paper on the field of camera objectives that the lenses had been displaced by an amateur cleaner and proposed that they be changed, but when it was considered that there were $\underline{|8}$* combinations of the surfaces, and that the Society wished to conclude their business at the latest in the month of August, it was left untouched. Personally I should have liked to see more discussion on some of the papers, but most of the members seemed to be too modest to say anything. The President, Professor Pickering, made an ideal presiding officer and that there was not more discussion was certainly not his fault, as every encouragement was given and a good example set by him.

* $\underline{|8} = 1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8 = 40{,}320$.—Ed.

Besides the reading of papers some other matters of business came before the meeting, the most important probably being a proposal to change the name of the Society to the American Astronomical Society. This proposal emanated from Professor Campbell and was generally supported, although it elicited some opposition. It seemed to be felt that, although it was well at the time of organization to include by special mention astrophysics as distinct from astronomy of position, for the reason that it was then comparatively new, the conditions were now changed, and astrophysics had such a well established position, the major portion of all recent equipments being devoted to the study of that branch of astronomy, that there was now no necessity to give it special mention as it would be naturally included in the new name.

Then, too, it was urged that the present name was very cumbrous, and the proposed change would overcome the difficulty. This matter, involving a change in the title, cannot, owing to a clause in the constitution, be voted on until the next meeting, but there seems no doubt the change will be made.

Although the executive committee have the fixing of the date and place of meeting, still they endeavoured to learn and follow the wishes of the members. Urgent invitations were extended by Professors Frost and Comstock to hold the next meetings at the Yerkes and Washburn Observatories, and at the time of, or directly after, the meeting of the British Association for the Advancement of Science in Winnipeg, in order that those of the British astronomers attending that meeting may be invited to take part. Although nothing was definitely decided the general consensus of opinion seemed to be in favor of the Yerkes Observatory at the time of the B. A. A. S. meeting.

The election of officers according to the prescribed methods occupied considerable time, as there is balloting for nomination as well as for election, and resulted in some change in the personnel of the executive committee. Professor Pickering was re-elected President, while Professor Comstock, who had held the office of Secretary since the organization of the Society, re-

tired and was elected First Vice-President. He was succeeded as Secretary by Professor Hussey. Again the modesty of some of the members was marked by the withdrawal of their names from the list.

The whole meeting was most successful and to me exceedingly enjoyable. What most impressed me there, as well as at my visit to some of the Observatories of the United States two years ago, was the geniality, kindliness, and good fellowship of astronomers. Although I may be prejudiced, I am sure in no profession or occupation can there be found so hearty a spirit of good-will and helpfulness as was evinced by everyone whom I met. If there is any professional jealousy such as is so evident in some other professions, among astronomers it is so carefully hidden away that I could find no evidence of it. They are like a large family working together in one common aim, and I cannot speak too highly of the willingness and eagerness with which any requests for advice or assistance were responded to.

MEETINGS OF THE SOCIETY

AT TORONTO

September 22.—The Secretary reported the receipt from the Dominion Government of a letter covering a cheque for $2,000, the grant to the Society. Mr. John A. Paterson referred to the generous increase in the grant and thought that a very special acknowledgement should be sent to the proper authorities. This proposal was supported by Dr. Chant, who expressed his appreciation and that of the members generally, of the handsome recognition of the Society's work by both the Dominion and the Provincial Government.

The Librarian referred to the most important accessions to the library during the summer months, and stated that there was a large number of copies of the *Transactions* for 1902–1903. The Librarian was authorized to give to members any of the back numbers of the Society's publications of which surplus copies are on hand.

Mr. A. F. Miller stated that he had not been able to see Comet Moorehouse. Mr. R. S. Muir reported having observed an interesting auroral display on September 13, and that the motion from east to west was very distinct. On the same night a brilliant meteor was seen. Mr. Muir also stated that, owing to the heavy haze caused by the prevailing forest fires, he had been able to see spots on the Sun with the naked eye. Mr. Andrew Elvins observed a good aurora on September 11 and Mr. J. E. Maybee one on September 4. Mr. Elvins also stated that he had seen many spots on the Sun during the last few weeks, some of them being very large.

The paper for the evening was on "The Effect of Atmospheric Pressure upon the Earth's Surface," by F. Napier Denison, of Victoria, B. C.

Mr. Denison described observations which he has made during the last ten years on the records obtained from the seismographs installed at the Victoria station of the Meteorological

Service. In addition to the ordinary undulations recorded by the seismograph, remarkable "wanderings" of the zero of the horizontal pendulum, often lasting for days, were detected. A continuous record of these movements has been kept since January 1899, and curves plotted to represent them. By studying these curves, in conjunction with the Synoptic Weather Charts of the Pacific slope the following information has been obtained:—

When the barometer is high over the Pacific slope from British Columbia to California, and low over the adjacent ocean, the horizontal pendulum is deflected towards the east.

When the barometer is high off the coast and low over the Pacific slope, the movement is towards the west.

In January 1907 Mr. Denison constructed a simple form of Milne pendulum to swing north-and-south. It is found that when the E-W pendulum swings west, the N-S one moves northward, and when the easterly swing is pronounced the other instrument travels southward. It is believed that these motions are caused by prevailing atmospheric pressures. Mr. Denison thought he had also detected the loading effect on the coast due to tides.

The reading of the paper was followed by an interesting discussion in which Mr. J. R. Collins, Mr. Maybee, Dr. Chant, Dr. Watson and Mr. Dushman took part.

The President read the following questions:—

1. Does the ecliptic change its position on the star sphere?

2. Why is the Moon at the time of an eclipse sometimes much further away than at others?

3. How is the orbit of a comet determined from three observations for position?

Discussion on the first question was deferred to a future meeting. The answer to the second was given as due to the elliptical orbits of both the earth and the Moon. It was suggested that as an answer to the third question can hardly be given in popular terms it be laid over for fuller treatment in a paper. Reference was made to the geometrical treatment of the problem in Chambers' *Astronomy*.

October 7.—The following was elected a member of the Society:

W. R. Ludewig, Pittsburgh N. S., Pa.

Mr. A. F. Miller reported having seen *Mira Ceti* well during the last fortnight. It was about equal to δ *Ceti* in magnitude, and he considered that its brightness is declining. It was not brighter than the third magnitude. Its spectrum is fluted like that of α *Herculis*.

Mr. Miller spoke respecting a question asked at the last meeting, whether the ecliptic moves among the stars. He stated that the precessional motion has no effect on the ecliptic, and illustrated his remarks by a diagram on the blackboard.

The programme consisted of a paper on "How a Planet is Weighed" by Mr. John A. Paterson, and a discussion on "The Aurora" led by Mr. J. R. Collins.

Mr. Paterson used the simplest of mathematics in dealing with his subject, and gave a very interesting account of the method used in comparing the masses of the heavenly bodies.

Mr. Collins showed a series of slides of Auroræ and commented on the different classes of the phenomenon, this being of particular interest at this time, several fine displays having occurred within the last few weeks.

October 20.—At the opening of the meeting the President referred to the recent death of Mrs. John A. Paterson, and expressed the deep sympathy of the members of the Society with Mr. Paterson in his bereavement.

The following were elected members of the Society:

Charles A. Playel, 4 Elmgrove Ave., Toronto.

William Taylor, China Inland Mission, Kiukiang, China.

Mr. A. R. Hassard stated that he had been engaged in making a 9½-inch reflector. He also reported having observed Saturn and the satellite Titan recently, and reported that on the 4th instant there were several large groups of spots on the Sun. The conjunction of Venus and Jupiter on the 15th instant had also been observed. Mr. Hassard also stated that he had seen the crepe ring of Saturn, which led to some discussion as to

whether the object of his scrutiny had been actually the crepe ring. Mr. Miller questioned the possibility of detecting this difficult object with a four-inch glass, and Mr. Hassard agreed to examine it again with the greatest of care.

Mr. Miller reported that there had been a very fine auroral arch on the evening of October 12th, reaching from the eastern to the western horizon, very bright and more than a degree in width.

MR. A. R. HASSARD'S 9½-INCH REFLECTOR.

The question, "Is it definitely known when and by whom the zodiacal constellations were grouped together and received the names by which they are now known?" asked at the last meeting, was discussed by Mr. Collins, who quoted a standard authority to show that the origin of the grouping and naming of the constellations is rather guessed at than known.

Mr. Musson gave a short account of the recent solar work at Mount Wilson Observatory, one of the results being that the

opinion is settled that sun-spots are in the nature of depressions in the solar surface.

The paper of the evening was one communicated by Mr. W. H. S. Monck, F.R.A.S., of Dublin, on "The Limits of the Universe." The paper was read by Mr. J. E. Maybee, who prefaced it by a synopsis of its contents. Mr. Monck discussed the number, magnitude and distribution of the stars, the illumination of the sky and the possible presence of matter in space which absorbs the star-light. The conclusion reached was that we have not yet sufficient data to allow us to determine whether the universe is finite or infinite.

At the conclusion of the meeting the members of Council present were asked to meet. By resolution Messrs. Collins and Chant were requested to write to Mr. John A. Paterson expressing to him the sympathy of the Society in his bereavement

E. A. D.

AT OTTAWA

October 9, 8 P.M.—Prof. A. T. De Lury of the University of Toronto gave the first lecture of a course of two on "The Scheme of Things," in the Normal School Assembly Hall before a large audience.

Professor De Lury in opening his lecture made suitable reference to the union of astronomical societies throughout the country with the Royal Astronomical Society of Canada, the parent society being in Toronto. He expressed the wish that interchange of lectures might be more frequent.

He attacked the subject of his lecture by supposing an observer, knowing nothing of the "Scheme of Things," noting the procession of the stars from East to West and the different paths taken as the altitude increased from the south; and, further, that for some distance above the northern horizon they moved from West to East. Continued observation showed that the stars appeared to circle around a point in the heavens not far

from the Pole Star. Professor De Lury illustrated this motion by a model.

Passing on he described the method of angular measurement and showed how by the invariability of the angular distance between two stars at different parts of the earth's surface, we conclude the stars to be at very great distances, and that consequently it is more reasonable to suppose their apparent motions to be due to the rotation of the earth on an axis pointed to the Pole than to the revolution of the stars around the earth.

A proof of the rotundity of the earth was given by the change in altitude of the stars as we go north or south, and the lecturer then proceeded to consider the motions of the Moon. The observer soon notes that in addition to its rising and setting, due to the daily rotation of the earth, it has a motion eastward among the stars, and it was developed from this,—from the time it takes to return to its original position, and from its comparative nearness,—that it revolves around the earth in about 28 days. A similar course of observation and deduction applied to the Sun, taking account also of its relatively enormous mass, leads to the conclusion that the earth revolves around the Sun once a year. Other bodies called planets, which appear to move irregularly among the stars, can have their motions completely explained by supposing them to revolve around the Sun similarly to the earth, though in different periods.

Obtaining thus the conception of the solar system and showing that by the varying apparent angular diameter of the Sun its distance from the earth must be changing and consequently that the path described by the earth is an ellipse, Professor De Lury concluded by briefly outlining the matter to be treated in the next lecture.

After the thanks of the Society and the audience had been suitably expressed by the President and Secretary, and after the abstract of his paper for the next meeting had been read by the President, the meeting adjourned.

J. S. P.

AT PETERBOROUGH

October 8.—The opening meeting for the session was held in St. Paul's schoolroom which had been chosen to accommodate the large audience. The programme consisted of a lecture by Rev. D. B. Marsh on "An Evening in the Skies," and it was probably the most entertaining and instructive lecture ever given in Peterborough.

The chair was occupied by the Vice-President of the Society, Mr. Herbert Collier, who told of the progress they were making, and mentioned in particular the work of several of the members. Mr. H. O. Fiske had fitted up at his home a most complete observatory for the taking of time, and his work was so accurate that errors of only one-fifth of a second had been made. In connection with this work the longitude of Peterborough had been determined with considerable accuracy.

On the imaginary journey conducted by Dr. Marsh, his hearers in imagination travelled over the surface of the Moon, the various planets and the stars, and looked upon the fiery face of the Sun. Photographs were displayed upon the canvas, of the heavenly bodies, bearing testimony to the changes brought about by the ages of the past.

The lecturer began by showing views of the earth. He then explained its motions and its relation to the various other planets and then passed on to the other bodies. The eclipses of the Sun and Moon were shown and described. The penumbra and umbra—the partial and total shadows—were well illustrated upon the screen.

Mercury, Mars, Jupiter, Saturn, Uranus, Neptune and the earth, accompanied by their satellites, were all commented on by the speaker, who gave their relative sizes and distances from the solar body around which they revolved.

The opinion entertained by many that the planet Mars is inhabited, was questioned by Dr. Marsh. Jupiter, from its intense heat, could not possibly be inhabited.

Many excellent photographs of the surface of our satellite, the Moon, were displayed. The mountain ranges, the channels, the sea beds, the craters of the volcanoes were all distinctly shown.

In connection with the Sun the speaker showed drawings of the hydrogen flames which are constantly shooting off from that great source of light and heat. These flames he termed the grandest sight one could wish to see, and he also displayed on the canvas photographs of sun-spots due to the explosion of gases.

In conclusion reference was made to a few of the constellations. Ursa Minor and Andromeda were presented upon the screen, and last, but not least, the giant Orion, which is considered the finest constellation visible in the heavens. It was explained that it took light travelling at the rate of 186,000 miles per second, 10,000 years to come from the latter named constellation, so great was its distance from the earth.

The lecture was received with great satisfaction by the large and intelligent audience.

E. F.

In a personal letter Mr. H. B. Collier states that he has received a new 3-inch telescope manufactured by Dr. Marsh and his young son With the exception of the lenses, the brass tubing and the nickel-plating, the instrument was entirely made in a "little cellar work-shop." Mr. Collier reports that the instrument is of the highest class, and that it will receive plenty of use.

EDITOR.

DOMINION OBSERVATORY NOTES

The Seismograph—Bosch Photographic—Magnification 120.—Below are the data of a number of earthquakes that have been recorded since the last Notes were sent.

With the transition from summer to autumn, and the accompanying change of meteorological conditions, with particular reference to isobars and gradients, microseisms have increased in frequency and intensity, reaching a maximum of nearly 6 microns absolute measure, from the zero line. As far as the observations here go, the association between microseisms and isobars is certainly intimate, as shown by the large number of coincidences between sharp gradients and microseisms. However, the whole explanation is not yet complete. It may be stated that, so far, no well-marked microseisms have ever been recorded here when a large area was covered by a "High" and the isobars were far apart.

Since last writing an open-wound platinum thermometer, Callendar record, has been installed. The thermometer frame has been placed within a wooden frame covered with fine mesh brass netting to protect it from being possibly short-circuited by spider-webs or other cause. The thermometer is placed within a standard thermometer shed near the observatory, and the scale of the bridge-wire was determined by readings of several standard mercurial thermometers placed within the thermometer shelter. The most marked feature of a continuous temperature record by means of an open-wound thermometer, that is, dependent upon the resistance of a fine platinum wire, instead of on the expansion or contraction of the mercury, is the rapid and almost constant fluctuations of the temperature of the air, often reaching a degree C. or more in a very few minutes, and showing that the atmosphere is far from being as homogeneous as it is thought to be. It is permeated by density *schlieren*.

Earthquakes recorded:—

August 14		N–S Component	E–W Component
		h m s	h m s
	1st P. T. began	0 49 48 G.M.T.	0 49 48 G.M.T.
	2nd " "	0 55 40	0 55 38
	P. P. "	1 00 08	1 00 09
	Duration	1 20	1 35
	Max. double amplitude	10 mm. at 1h 03m 52s	17 mm. at 1h 08m 16s.

The epicentre is estimated at 3,900 km.

August 17		N–S Component	E–W Component
		h m s	h m s
	1st P. T. began	10 56 00 G.M.T.	10 56 15
	2nd " "	11 03 07	11 03 07
	P. P. "	11 12 00 ?	11 12 00 ?
	Duration	2 20	2 30 ?
	Max. d. a.	2·5 mm. at 1h 12m 12s	2 mm. at 11h 12m 12s.

Distance to epicentre 5,400 km.

August 18		N–S Component
		h m s
	1st P. T. ?	11 16 08 G.M.T.
	Maximum	11 20 40
	End	11 40.

This appears to be of the earthquake reported from Eureka, California.

August 19		N–S Component	E–W Component
		h m s	h m s
	1st P. T. began ?	23 42 00 G.M.T.	23 42 00 G.M.T.
	2nd " " ?	23 47 00	23 47 00
	P. P. "	. . . .	. . . .
	Duration	0 18	0 18
	Max. d. a.	1·6 mm. at 23h 47m 48s	1·8 mm. at 23h 47m 48s.

August 20		E–W Component
		h m
	1st P. T. ?	10 21 G.M.T.
	Long waves	10 43
	End	11 33
	Phases not distinguishable.	

August 22		N–S Component	E–W Component
		h m s	h m s
	1st P. T. ?	19 31 G.M.T.	19 32 G.M.T.
	2nd " began	19 36 22	19 36 22
	P. P. "	. . . .	. . . .
	Duration	0 32	0 43
	Max. d. a.	1·5 at 19h 36m 22s	1·3 mm. at 19h 42m 00s.

August 23		N–S Component	E–W Component
		h m s	h m s
	Waves	19 22 29 G.M.T.	19 22 28 G.M.T.
	End	19 26	19 26.

August 29		N–S Component	E–W Component
		h m s	h m s
	1st P. T. began ?	18 15 20 G.M.T.	18 15 18 G.M.T.
	Long waves		18 25 00
	Max. d. a.		1·5 mm. at $18^h\ 24^m\ 10^s$
	End		19 00.

September 21		N–S Component	E–W Component
		h m s	
	1st. P. T.	masked by microseisms	
	2nd "	6 55 47 G.M.T.	. . . .
	P. P.	7 07 40	
	End	9 00	
	Max.	4 mm. at $7^h\ 12^m\ 16^s$	9 mm. $7^h\ 16^m\ 08^s$.

Several maxima are shown by both components.

September 23		N–S Component	E–W Component
		h m s	h m s
	1st P. T. ?	13 05 00 G.M.T.	13 05 00 G.M.T.
	Long waves	13 10 00	13 09 40
	End	13 21	13 26.

October 13			
	1st P. T. began	5 13 28 G.M.T.	5 13 26 G.M.T.
	2nd " "	5 19 02	5 19 02
	P. P. "	. . . .	. . . .
	Max. d. a.	8·5 mm. at $5^h\ 35^m\ 50^s$	11 mm. at $5^h\ 38^m\ 00^s$.

Before this quake had quite died out another one was superposed.

	6 52 38	6 52 38
End	8 00	8 00.

O. K.

Astrophysics.—So far as observing work is concerned very little has been done here recently. The constant smoke for the past six weeks has much hindered micrometric measurements with the refractor and almost entirely prevented spectrographic work. Experience has shown that, even in what appears comparatively slight smoke, doubling the normal exposure gives only a faint trace of star spectrum and consequently it has only been on two or three nights that any spectra have been obtained.

Observations of two first type stars recently made here have shown them to be variable in their velocity. The data following give the evidence of their binary character.

γ Aquarii.

$\alpha = 22^h\ 16{\cdot}5^m$. $\delta = -1°\ 53'$.

PHOTOGRAPHIC MAGNITUDE 4·1.—TYPE OF SPECTRUM VII*a*.

PLATE NUMBER	GREENWICH DATE	VELOCITY
1745	July 29·86	− 18 km. sec.
1770	August 5·81	− 8
1779	" 7·81	+ 3
1790	" 17·81	− 40
1847	" 28·70	− 7
1858	" 31·77	+ 23.

ι Andromedæ.

$\alpha = 23^h\ 33{\cdot}2^m$. $\delta = +42°\ 43'$.

PHOTOGRAPHIC MAGNITUDE 4·4.—TYPE OF SPECTRUM *A*.

PLATE NUMBER	GREENWICH DATE	VELOCITY
1772	August 5·87	− 6 km. sec.
1781	" 7·87	− 11
1832	" 26·87	+ 12
1922	October 9·75	− 11
1928	" 12·69	+ 11
1939	" 19·63	+ 32.

Both of these stars are undoubtedly binary although the evidence for *ι Andromedæ* was not so conclusive until the last plate was measured. Although the spectra are fairly good, the dispersion is small and there is the possibility of accidental variations when only two or three lines are measured, but not, of course, over so large a range as even the earlier plates show. The investigation of both these stars will be continued.

Some measurements have been made and photographs secured of Morehouse's Comet by Mr. Motherwell, the photographs showing some peculiar features in the tail, but the smoke has been and is too dense to secure much data.

Dr. De Lury has been engaged in investigating the character of the Michelson plane grating used as the dispersing piece in

the 23-ft. focus solar spectroscope. It seems to possess some peculiar properties of which probably the most important is the marked improvement obtained in the definition in the higher orders when part of the ruling is occulted.

A special slit with reflecting prisms for bringing opposite limbs or different parts of the Sun's surface into juxtaposition, with other appliances for facilitating the detailed spectroscopic examination of the Sun's surface, has been ordered from the J. A. Brashear Co. and will shortly be completed and put into use.

J. S. P.

ASTRONOMICAL NOTES

"PROFESSOR E. B. FROST, Director of the Yerkes Observatory, calls attention to the recent increase of brightness of Morehouse's Comet, and writes on October 29 :—

"'It was visible to the naked eye, and three or four degrees of tail could readily be seen in a small field glass. Three spectrum plates were obtained with the Zeiss ultra-violet doublet and objective prism by Mr. Parkhurst with some assistance from me. Two of these had exposures of one hour. No continuous spectrum was perceptible, whence we may reach the important inference that last night the comet's light was very largely intrinsic. Seven bands were very conspicuous as knots on the plate. I am measuring the spectra this morning, but have no doubt that they will prove to show the ordinary hydrocarbon spectrum.'

"The photographs taken last night at the Harvard Observatory, show a tail at least nine degrees in length, and much longer than on previous nights."—Edward C. Pickering. (Harvard College Observatory *Astronomical Bulletin*, October 31, 1908.

THE Ephemeris of this comet has been computed by Einarsson and Meyer of the Lick Observatory staff as follows :

		R. A.	Decl.
October	25·5	19h 04m 47·6s	32° 42′ 22″
November	2·5	18 56 56·1	20 43 30
"	10·5	53 03·2	+ 10 55 15
"	26·5	50 32·1	− 3 22 55
December	12·5	50 11·0	13 25 45
"	28·5	18 49 54·8	− 21 33 54

Brightness September 3 = 1·00 Perihelion passage December 25.

—*Lick Observatory Bulletin No. 139.*

"PROF. F. W. DYSON, Astronomer Royal for Scotland, in a paper on the systematic motions of stars, laid stress on the results obtained from the examination of 1,800 stars, each having a proper motion greater than 20″ in a century. The angles be-

tween the direction of motion of each star and the directions of two apices were computed, and it was found that of these 1,800 stars 1,000 were moving in a direction within 60° of one apex, 600 within 60° of the other apex, and about 100 were not moving towards either apex. The directions of motion of the 100 were capricious and irregular, and did not tend to any point of the sphere. The investigation was not completed, but in some respects was not in accordance with what Mr. Eddington had found, so far as the velocity of the two streams was concerned. The evidence did not point to the velocity of the first stream being three times as large as that of the second stream. There was no doubt but that the apparent motion of the stars was directed to two points in the sky, but a difficulty was presented in the explanation of this being due to the existence of two streams."—*The Observatory*, October, 1908.

J. R. C.

AURORA BOREALIS

Wierd armies wave their scimitars of light
And sabres glimmer in the cloudless deep
While up the ebon battlements they sweep
With shimmering steel exultant to the fight.
They charge, contend, retreat with sudden flight,
Then press again the battle up the steep
Till all the northern skies with lances leap
Around a flaming coronal of night.

But soon the legions and their splendors fade;
Each bright battalion in the lofty arch
In midnight's scabbard sheathes his blood-hued blade;
The ranks from zenith to horizon march
And where was camp and panoply of Mars
Is sable night pierced by the jewelled stars.

—A. D. WATSON, Toronto.

SUMMARY REPORT OF THE WEATHER IN CANADA

AUGUST, 1908.

TEMPERATURE.—The temperature was from 1 to 2 degrees above the average in the Lake Superior district and over a portion of the Georgian Bay region, but in all the large remaining portion of the Dominion the average was nowhere exceeded. The negative departures were small, however, and nowhere exceeded 3 degrees. The greatest departures recorded were in Northern British Columbia, Northeastern Saskatchewan, in Manitoba, the Ottawa Valley and in the Bay of Fundy district.

For the highest and the lowest temperatures at various stations see the accompanying table.

PRECIPITATION.—In British Columbia the rainfall was slightly in excess of the average in Caribou but very deficient elsewhere. In Alberta it was everywhere less than the normal, as much as 50 per cent. in some localities. In Western Saskatchewan the rainfall was also sparse, but over the remainder of the Province and also in Manitoba rather more than the usual quantity was recorded. In Ontario it was more than the average over the larger portion of the Province, the exceptions to the prevailing conditions occurring in the Ottawa valley and the eastern part, where little rain fell. In Western Quebec the rainfall was also deficient, but in the middle and eastern portions of the Province the average quantity was well exceeded. In the Maritime Provinces, except in a few isolated localities, the rainfall was greater than the average; this was especially the case in certain localities, noticeably in the vicinity of Halifax, where for the month it totalled nearly eleven inches, which is almost six and one half inches above the normal quantity.

SEPTEMBER, 1908.

TEMPERATURE.—The temperature was well above the average in all portions of the Dominion; the most noticeable

Temperatures for August and September

Station	August		September		Station	August		September	
	Highest	Lowest	Highest	Lowest		Highest	Lowest	Highest	Lowest
Yukon					Lakefield	84	46	87	36
Dawson	78	32	60	10	Lucknow	91	37	90	34
British Columbia					Midland	90	58	90	48
Agassiz	98	42	79	30	North Bruce	91	45		
Atlin	68	34	58	24	North Gower	91	39	89	33
Barkerville	78	34	70	18	Otonabee			86	41
Kamloops	96	46	86	30	Ottawa	86	45	89	37
Nelson			84	29	Owen Sound	90	40		
New Westminster	92	46	76	30	Paris	93	43	92	33
Victoria	84	46	75	34	Parry Sound	90	43	84	40
Western Provinces					Peterboro'	89	39	91	31
Aweme			96	26	Point Clark	95	43	89	43
Battleford	86	34	90	20	Port Arthur	85	36	86	31
Brandon			94	22	Port Burwell	86	43	79	34
Calgary	84	34	84	21	Port Dover	89	43	86	36
Carberry			94	15	Port Hope			86	41
Carman			91	24	Port Stanley	84	43	78	34
Edmonton	84	31	81	18	Rockliffe	85	39	83	31
Medicine Hat	103	38	90	28	Sarnia			99	41
Minnedosa	88	32	89	27	Southampton	87	42	87	40
Moosejaw	91	32	96	10	Stony Creek	97	43	97	36
Morden			92	28	Stratford			85	31
Oak Bank			87	29	Toronto	92	43	90	37
Portage la Prairie			93	28	Uxbridge	88	38	91	33
Prince Albert	78	34	78	18	Wallaceburg				
Qu'Appelle	84	30	92	20	Welland				
Regina					White River	86	32	86	30
St. Albans					Windsor				
Swift Current	102	38	90	18	*Quebec*				
Virden			92	24	Brome	82	36	85	26
Winnipeg	90	32	91	26	Father Point	78	42	75	34
Ontario					Montreal	82	48	84	40
Agincourt	92	43			Quebec	82	46	82	36
Aurora	89	36	92	30	Sherbrooke	90	39		
Bancroft	89	34	91	29	*Maritime Provinces*				
Beatrice	85	35			Charlottetown	83	46	79	44
Bloomfield					Chatham	85	42	84	36
Brantford	92	41	93	30	Fredericton	83	40	84	30
Bruce Mines	82	36	84	32	Halifax	82	42	80	34
Clinton	90	39	88	36	Hamilton, P.E.I.				
Cockburn Island			88	37	Moncton				
Copper Cliff			85	35	Parrsboro'			72	39
East Toronto			86	39	Port Hastings			79	30
Gravenhurst	85	38			St. John	76	47	77	39
Haliburton					St. Stephen	84	33	87	28
Hamilton	92	47			Summerside	76	43	80	39
Huntsville	82	40			Sussex	81	36		
Kingston	78	45	77	37	Sydney	84	42	79	37
Kinmount	89	30	84	28	Yarmouth	74	42	74	34

positive departures were 6 to 8 degrees in the Lake Superior district, 4 to 5 degrees in Saskatchewan and Manitoba, and 3 to 5 degrees in the peninsula of Ontario and in the Ottawa and Upper St. Lawrence Valleys.

For the highest and the lowest temperatures at various stations see the accompanying table.

PRECIPITATION.—During the month a severe drought occurred in nearly all portions of the Dominion, the Province of Manitoba proving the exception to the rule with a rainfall in most localities of from 3 to 19 per cent. more than the usual amount. In parts of Southern Alberta and more locally in Southwestern Saskatchewan the rainfall was *nil*; elsewhere from coast to coast, except in Manitoba as already stated, the quantity recorded was equivalent to about a third of the average.

METEOROLOGICAL OFFICE,
TORONTO, CANADA,
October 31, 1908.